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ABSTRACT

Taking a broad view of technology, this publication discusses its potential for education and examines the implications of a technology-oriented curriculum. Chapter 1 identifies the increasing importance of technology in the workplace, home, and forms of communication. Evidence is cited that suggests that emerging technologies can be expected to change the means of accomplishing tasks, institutions, and individual roles therein. Chapter 2 addresses the educational potential of technology from the perspectives of content, outcomes, and methodologies. The importance of integrating technology within the curriculum is emphasized, and examples for doing so are offered through a citizenship approach. The need for planned organizational change is discussed in chapter 3, which notes that consideration for the changing roles of individuals and establishing a climate for innovation are important. Finally, technology is examined in terms of its future and its potential to generate change, and it is concluded that the integration of technology into schools on a large scale raises issues concerning personnel, resources, management, programs, and administration. A glossary of important terms is provided. (39 references) (DB)

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INTEGRATING TECHNOLOGY into the CURRICULUM

Ohio Department
of Education
1987

A Leadership Guide

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Foreword

On July 20, 1969, the most highly shared learning experience in history occurred as Neil Armstrong became the first human being to set foot on the moon. Nearly 2 billion people on earth shared this historic moment of human achievement. No one that day could be unimpressed with the technology that enabled man for the first time to reach beyond the planet of his birth.

Equally inspiring was the realization that in our homes, schools, and workplaces, we were observing history in the making. This feat, also the product of technology, enabled pictures taken on the moon to be converted to signals and transmitted 180,000 miles back to earth, eventually reaching millions of separate devices across this planet for our individual viewing.

Educationally, the event exemplified the use of multimedia to bring information to viewers. Television networks prepared us for the actual lunar activity through background consisting of expert interviews, still photography slides, astronaut tape recordings, graphic materials, and earlier videotapes. Teachers, in the week preceding the landing, used charts, diagrams, physical models, filmstrips, and written materials to prepare students for the viewing and to enhance their understanding of the moon mission. Technological vocabulary was introduced and explained: docking, reentry, escape velocity, lunar landing module, communications blackout, and retrorockets.

Subsequent follow-up through newspaper and magazine articles, dialogues among friends, classroom discussions, assignments, and reports made the landing on the moon an in-depth, well-articulated, and comprehensive learning experience. Media were more than the object of study. It was the means of study. It was the most appropriate and practical method of study. Most importantly, the event consisted of a total, well-integrated educational unit suited to meet well-identified learning goals. These are the hallmarks of educational technology; hallmarks that represent a challenge to educators who want to integrate technology effectively into the curriculum.

Table of Contents

Introduction 4

Chapter I Changing Role of Technology 6
A Changing Educational Purpose 9
The Relationship of Technology to Education 10
An Expanding View of Educational Technology 11

Chapter II Technology and the Curriculum 13
Educational Value 13
Altering the Curriculum 15
Purposes 17
Design of Instruction 18
Evaluation 19
A Citizenship Approach to the Total Curriculum 20
Citizenship Goals 21
Examples of Expanded Goals 22

Chapter III Technology, an Avenue to Change 26
Technology and the Individual 26
Tenets 27
Changing Roles 28
Inservice 29
Innovative Climate 30
Institutionalization 31
Documented Barriers to Implementing an Innovation 31

Chapter III (continued)

Technology and the School 32
Matching Goals to Curriculum 32
Utilization 33
Costs 34
Technocracy 35
Measured Response 36
Real Literacy 37
Leadership 38

Chapter IV The Future 40
Focus on Process 40
Peopleware 42
Learning Outcomes 43
Conclusion 45

Glossary 46

Bibliography 53

Introduction

Integrating Technology into the Curriculum has been prepared in response to the rapidly expanding application of technological hardware, software, and other materials to schools' curricula during this decade. The purpose of this publication is to take a broad view of technology, discussing its potential for education and examining the implications of a heavily technology-oriented curriculum.

The publication consists of four chapters. Chapter 1 takes a series of snapshots of the use of technology in our daily lives. It identifies the increasing importance of technology in our workplaces, homes, and forms of communication. The impact of relatively inexpensive microelectronic devices on our current society is contrasted to three other comparable revolutionary periods in our history. Strong evidence is cited to suggest that emerging technologies can be expected to change dramatically our means of accomplishing tasks, our institutions, and our individual roles therein.

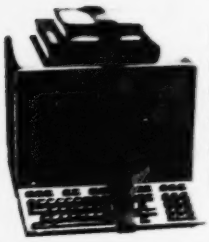
Chapter 2 addresses the educational potential of technology from the perspectives of content, outcomes, and methodologies. It underscores the importance of integrating technology within the curriculum as part of a learning system, discussing a model for that kind of instructional design. Specific examples are offered for incorporating technology within the curriculum through a citizenship approach.

Chapter 3 explores issues in institutionalizing technology in terms of the individual and the school. It emphasizes the need for planned organizational change, giving appropriate consideration to the changing roles of individuals, and establishing a proper climate for innovation. Also discussed is the contribution of the school operation in reinforcing or detracting from the classroom application of technology.

Chapter 4 is a closing look at technology in terms of its future and its potential to generate change. The integration of technology into schools on a large scale raises issues concerning personnel, resources, management, program, and administration. A future glimpse at changes likely to ensue through technology is provided.

This booklet has been written for those people of the educational community—school board members, administrators, supervisors, and other decision makers—who will be providing the leadership for planning and executing an educational program for the citizens of the 21st century. It is a forward-looking document predicated upon the thesis that education is the dynamic agent of our society most responsible for preparing our young for active and full citizenship in our world. Changes associated with education-related technology are occurring at an unparalleled rate. The challenge to education decision makers to provide energetic and wise leadership in meeting those changes has never been greater.

Chapter I Changing Role of Technology



Glimpse: A busy industrial setting filled with the activity of human and robot workers toiling side by side. The people, engaged in good humor and lively conversation to pass the time, casually accept the goods brought by their silent co-workers and the parts passed down the assembly area from the previous position where a robot does its assembly job.

A horn sounds ending the work shift. The humans, hardly pausing in their friendly banter, gather their personal belongings and exit the assembly area none too slowly. The robots continue working, some of their job functions changing with the withdrawal of their human counterparts. But the general flow of activity remains constant. As we hear, "Goodnight, Ralph" in the background as the last person departs, the work area darkens and the temperature begins to drop. Significant differences between the workers in this unusual industrial setting slowly become apparent. (Fade)

Glimpse: A sales manager gathers her 5-member sales force in a small conference room equipped with a color TV receiver and videodisc player. She passes out promotional literature from the marketing division of their parent company concerning a new product line being introduced. Part of the material refers to information contained on the videodisc which the manager slips into the laser disc player.

During the next hour, the six people discuss the information supplied by the videodisc on the new product. The random access capability of the machine permits immediate access to different parts of the disc material with a simple digital input. This allows the salespeople to concentrate on different aspects of the product line. The combination of stills, stop-action, reverse motion, superb color, and sound quality impresses the group with the prospects of using certain parts of the presentation with customers. (Freeze frame)

Glimpse: Originating from PTV station WNEW in New York City is a special medical education telecast which is part of an audio-interactive

videoconference. The Hospital for Special Surgery in New York City is responsible for material being presented under the sponsorship of the orthopedic division of a major medical supplier. WNEW sends its broadcast out over Westar IV to 26 PTV stations and ten hotel meeting sites where the program reaches 2,000 participating physicians and surgeons at 35 remote locations.

Mobile downlinks are used to receive the broadcast at all but three sites. Two receive the program via telephone lines and one by microwave transmission. About one-third of the three-hour conference is devoted to a question-and-answer session through phone-links back to the originating studio. (Dissolve)

The glimpses just taken are not projections of near future applications of technology. They are snapshots of current activities which utilize emerging technology to the fullest. Industrial robots first became visible in 1970 when approximately 200 were in operation across the United States. By 1983, this figure had grown to 7,000. It is anticipated to reach 10,000 by 1990.

The cost-benefit argument of robot use is nearly irresistible. Products produced by robots are cheaper and more reliable in quality than human produced goods. Operating costs for robots fall between $4 and $5 an hour for a six-axis, servocontrolled, computer-driven (sophisticated) robot, amortized over eight years. By comparison, the average automobile assembly worker's pay is approximately $16 per hour (Blaesi, 1984, p. 101).

Videodisc technology has made that medium nearly ideal for dense storage tasks, ease of handling, and durability. One 30-minute side of an optical videodisc has the storage potential for 54,000 stills. This is equivalent to 675 carousel slide trays (80-slide capacity), thirty 300-page textbooks, or 3.5 million x 54,000 bits of computer information. The color capability of the disc is superb and the sound quality comparable to stereophone recordings. Videodisc uses range from mail-order teleshopping to cataloging of museum art items to recruiting information from colleges (Winslow, 1981, p. 38).

Teleconferencing has become a major means of communicating with large or special interest groups at distant locations. The number of satellites put into synchronous orbits since 1970 has made this means of conducting conferences attractive enough that one major motel chain now has 280 downlink sites located across this country. A typical example occurring in January 1982 permitted Firestone Tire and Rubber Company to introduce its latest passenger car tire to more than 2,000 dealers, company store managers, and field personnel. The four-hour teleconference uplinked to Westar III from two sites, Cleveland and Daytona Beach, for transmission to 25 cities throughout the United States.

Technology is making ever-growing advances into the mainstream of modern life. We are incorporating increasingly sophisticated technology into the workplace, into our manner of communicating, into the way we access information, into the means used for keeping current in our chosen professions. "Banking hours" have become nonexistent with 24-hour automated teller and home banking services. Home information centers provide access to data banks on such diverse topics as UPI news dispatches, stock market information, home-buying and-selling services, background data on major corporations—even the contents of the World Almanac. Home entertainment centers boast an unending array of music, movies, videogames, multichannel reception, and even audience input devices. In using a credit card, our credit is checked in seconds via telecommunication channels that span oceans and continents to a computer that determines whether our credit limit has been exceeded or the card stolen.

The majority of technological applications we employ today have become visible within the last fifteen years. The pace at which startling breakthroughs have been achieved in miniaturization, processing speed, and personal access to powerful tools is truly phenomenal. For a few hundred dollars, one can obtain modern computer circuitry that provides computing power obtainable only through an investment of millions of dollars in the 1950s. This computing power is packaged in a unit whose physical size has shrunk by a factor of 10,000 while the speed of the equipment has increased 50,000-fold (Council on Learning, 1980, p. 11).

A Changing Educational Purpose

Historically, the adoption of a new technology has led to change, often dramatic change, in culture, social structure, and lifestyle. If widespread adoption of technology occurs in education, what are the changes likely to be?

—Robert Stakenas

The primary purpose of our schools is to prepare our citizens to be useful members of society. The development of a curriculum to achieve this end grew largely from the needs of an industrial society. Workers were expected to be equipped with basic skills, conform to rules and regulations, be prompt and regular in job attendance, and work on routine and repetitious tasks.

However, the traditional American industries which characterized an industrial society—automobiles, steel, manufacturing—have begun to give way to high-technology, information, knowledge, and service industries. The significance of this changeover has consequences for education that go to the very structure of its foundations. The 1972 report of the Carnegie Commission on Higher Education describes the impact of communications technology on American society as **THE FOURTH REVOLUTION**, comparing this period in our history to three earlier education revolutions:

1. The first revolution occurred when societies began to differentiate adult roles and shift the task of educating the young from parents to teachers; from the home to the school.
2. The second revolution took place with the adoption of the written word as a tool of education—superseding the prevalence of oral instruction.
3. The third revolution was marked by the invention of printing and the subsequent availability of books.
4. The fourth revolution is identified as recent developments in electronics and their applications to instructional purposes: radio, video, computers, tape recorders, videodiscs, etc.

Workers in new hi-tech knowledge companies that supersede labor-intensive production industries will require greatly different skills. These companies will draw upon people who can handle complex intellectual tasks, who continually renew and update their education. These workers

will be self-directed and self-organizing. Knowledge workers will be flexible and adaptive to change, ready to embrace new ideas, tools, and job functions.

Educational institutions and curricula which prepare students for this new society or which retrain graduates for changing job roles will not be the ones of the past. We cannot depend upon evolutionary changes to meet these emerging needs. Purposeful plans, goals, management schemes, timelines, and allocation of resources are necessary for education to meet its primary objective and to keep pace with the rest of society. Traditional change processes for meeting this revolution will be no more effective than existing curricula for providing that education.

The Relationship of Technology to Education

In a broad sense, it has always been true that, in time of change, the world belongs to those who can grasp the nature of that change and fashion their life and culture to make the most of it.

—James D. Finn

History suggests that new technologies are often overrated in the short run but vindicate their prophets in the long run. Acceptance of new technology is influenced by cultural, social, and lifestyle factors. Existing organizations, power structures, and vested interests are often threatened. The individual may suffer mental, emotional, financial, and geographic dislocation.

To overcome these kinds of inhibiting factors, there must be a revolutionary climate for receptivity to new ideas. There has to be recognition of the need for change and broad support for new approaches. Individuals must possess a background of experience enabling them to delineate and pursue long-range goals through systematic and careful planning.

That background has never been more conducive to a meaningful use of technology than at the present. Emerging growth industries and traditional occupation groups are recognizing the need for different sets of worker skills than have been previously developed through education. Technology has become pervasive in the work sector as well as the private and entertainment sectors. Communities expect and support curricular innovation that incorporates technology.

Many teachers and administrators have had the opportunity to explore technological devices in informal, experimental settings. They have become knowledgeable about the potential of technological devices and their limitations. They sense the need to move to the next level of incorporating technology into the curriculum fully not as an adjunct device, not as an object of study—but as a means to achieve well-defined objectives that relate to the goals of preparing students for a high-technology world.

The most compelling argument for full utilization of technology in education concerns the prevailing force driving curriculum change. As we move from content-centered approaches to objective-based curricula, the need for multiple resources becomes more pronounced. As schools move away from a model of content coverage to one of measurement of performance, educators look to technology as a means to improve well-defined and tightly knit objectives.

An Expanding View of Educational Technology

Educational technology is about instruction and learning...At its best, educational technology addresses the design and implementation of systems of learning.

—Robert Stakenas

The single most important application of technology to education has been the written word. Writing enabled knowledge to be transmitted from a source who did not have to be physically present. From that most significant outset, educational technology has expanded to include contributions from the physical sciences, management sciences, and behavioral sciences. Educational technology involves people, procedures, ideas, devices, organization, management, and settings.

The most narrow view of educational technology focuses upon the transmission of information by alternate means of communication—television, films, computers, tape recorders. This aspect of technology takes discoveries from the physical sciences in the form of projection devices, integrated circuits, and microprocessors, and fashions them into tools appropriate for a specific educational job function. The resulting devices—television receivers, videocameras, computers, and word processors—provide new dimensions in offering instruction in alternative ways.

Frederick Taylor, the father of scientific management principles, introduced procedures for analyzing a work task and designing a way to accomplish that work more effectively and efficiently. Taylor found that work could be done more effectively if these steps were followed:

1. Identify the work to be done.
2. Break the work into its individual operations.
3. Design the best way to do each of these operations.
4. Arrange these operations in a sequence that will allow the worker to complete them in the fastest and most economical manner.

Taylor's work shifts the focus on technology from the work task to the planning of that work. From this management science area has come a systems approach to the use of technology which considers management, needs assessment, instructional design, scheduling, learning systems, and the structuring of the educational institution itself. In this context, the tools of technology are more likely to be integrated within the curriculum as elements of a goal-directed learning experience.

The behavioral sciences lend a technology perspective that focuses upon the learner. Principles such as repetition, reinforcement, motivation, perception, cognition, learning, and measurement are considerations in the design and execution of instruction. Technology becomes an important aspect in the identification and application of each of these principles.

As perceptions have expanded from that of technology as a tool to that of technology as a system, it has become important to realize the appropriate initiating point for curricular revision and design. Instructional media the tools - can support and facilitate learning. However, they cannot identify worthwhile educational goals, cannot completely manage learning progress, cannot decide upon a suitable point for intervention. The appropriate starting point is to identify that which is to be accomplished.

A narrow view of technology is limiting. It leads to decisions to adopt innovations based upon the belief that they are better, are needed, or are most cost effective. It tends to restrict thinking to the use of technology to conduct conventional activities more efficiently or to goals which entail teaching about the technology itself. It inhibits the ability to incorporate technology into a comprehensive instructional unit that is goal directed and objective based. It prevents consideration of new and exciting ways to apply technology.

Chapter II Technology and the Curriculum

"Would you tell me, please, which way I ought to go from here?" (asked Alice) "That depends a good deal on where you want to get to," said the Cat.

—Alice's Adventures in Wonderland

The curriculum application of technology merits a closer look at factors which can inhibit or promote its effectiveness. Awareness of particular strengths and weaknesses is necessary in identifying where to apply technology and how to use it to fullest advantage. Developing and maintaining a program emphasizing technology requires a sensitivity to elements which determine successful implementation.

Educational Value

The most important canon for judging the value of technology to a particular learning goal can be stated this way: **Does it provide a significant dimension to the learning experience impossible or severely restricted in its absence?** The answer to this question is a resounding YES if it is used appropriately and effectively. Some examples illustrate this point:

- The use of calculators in mathematics classes can remove the tedium of lengthy calculations permitting students to focus upon the discovery of properties or patterns resulting from examination of numerous examples. By "speeding up" the calculation process and assigning that function to a device, students are more willing to consider other aspects of a learning situation, such as that of problem solving. (An unstated message is transmitted to students who are being permitted to use calculators: something more than a rote procedure is expected from you.)
- Tachistoscopic devices control a child's visual exposure to printed materials. This equipment can be used in a clinical setting for students requiring systematic left-to-right eye movement practice. Coupled with an audio component, such devices can provide early reading practice with small groups of students in the classroom, extending the teacher's opportunity to work with other students who require more individual assistance.

- The production of a radio or television program exposes students to the characteristics of a different communication medium. The understanding gleaned from their own production sharpens their critical assessment skills in viewing or listening to professionally produced programs. Most importantly, students apply skills practiced within individual disciplines, such as writing, speaking, and graphics production, in a "realistic" setting which requires the integration of these skills to produce effective communication.
- Commerically available tests provide information not easily accessible by other means. Carefully researched and validated tests offer diagnostic information about skills, assessments of aptitudes and intelligence, normative comparisons with groups, interest inventories, and psychological data about behavioral or learning disorders.
- Electronic storage materials and devices such as microfilm, microfiche, hyperfiche, and ultrafiche contain up to 3,000 pages of information on film the size of an index card. Coupled with electronic data bases such as OnLine Computer Library Center (OCLC), students have access to a wealth of information not previously manageable. Working with such large quantities of information and using the hardware and software demands vastly upgraded study and research skills.

These examples underscore several important features of technology.

Contemporary/Relevant. The products of technology keep learning experiences current and meaningful. Students can readily relate to learning activities that reflect state-of-the-art application outside the school environment. The motivation to learn is implicit in acquiring knowledge and skills that have immediate application. The effect on teachers and the curriculum is to keep each updated, fresh and full of excitement.

Higher Taxonomies. The capabilities offered by technology frequently demand higher level skills from students. Students may be asked to apply their knowledge and understanding to situations requiring critical thinking, decision making, and evaluation. The nature of learning activities engages students in problem solving, often allowing a different aspect of the learning situation to receive emphasis.

Immediacy. The high speed capability of many technological devices provides students with quick responses to their efforts. Computer assisted

instruction or a simulation, for example, gives learners immediate feedback about the correctness of responses or the implications of ideas. This allows learners to assess performance or understanding and proceed without interruption of learning.

Interaction. Unlike more passive learning means, technology elicits the active response of the learner. The instructional activity continuously requires input, direction, and decision making from the student. The device responds uniquely to these actions. What is done or not done by the student drastically affects the outcome of the activity. The student thereby gains a sense of command over the learning experience.

Extended Capability. For many students, the powerful nature of technology has a stimulating effect. Sophisticated devices are under their control, and with them they can accomplish difficult or complex tasks clearly beyond their personal means. Technology stimulates students' curiosity and challenges their ability to carry their learning beyond formal instruction.

Altering the Curriculum

"I have never studied the history of the typewriter, considered the ethical questions of its possible misuse, or had any formal instruction in its operation. But, it is a familiar tool in my home that I draw upon as the need arises."

The least productive approach to making a curriculum adjustment to reflect technology is to teach about the technology itself. Many current literacy courses suffer from having so much time spent on learning the technical terms for pieces of hardware, studying the legal and ethical questions associated with technology use, or mastering a detailed set of instructions required for optimum use of the tool.

Relegating this kind of information to a single course ignores the transitory nature of the need for such "literacy." As instructional tools, such as computers, become widely available outside schools, students quickly acquire the kind of "working knowledge" of such devices that this type of course provides. A single course is also not the appropriate place in the curriculum to study aspects of a particular technology out of context from related ideas that should be considered. Legal and ethical issues relating to use of the technology should be part of larger units of instruction dealing

01 13

with responsible citizenship and our system of laws and individual rights. Specialized language or applications study should be the content of an elective course.

The starting point in any technological process is determining what is to be accomplished. The following model, adapted from one developed by Derek Rowntree, indicates the three phases in applying educational technology.

Purposes

Identify aims
Describe students
State measurable objectives
Consider assessment/evaluation

The first stage of this process consists of identifying the purposes for the particular instructional unit.

Identify Aims. What are the aims of the unit and what changes in student knowledge or behavior are intended? The aims of the unit need to be examined in relation to broader goals of the school or district. Consideration should be given to other related units that are part of this grade/course, discipline, or other disciplines.

Describe Students. An assessment of student learning characteristics and other needs should be examined. What entering information do students possess and what range of backgrounds, interests, attitudes, and skills do students have? It may be necessary to group students according to this kind of information or to restrict the instructional unit to a particular group based upon age, course of study, or prerequisites.

State Measurable Objectives. To determine whether the instructional unit meets its purposes, clearly defined objectives should be set forth. Expected outcomes should be stated in measurable terms. Objectives should reflect the full range of cognitive, affective, and psychomotor considerations identified in aims and student needs.

Consider Assessment/Evaluation. How will you determine if the objectives have been met? What instruments or means of assessing objectives will be needed? Will preassessment or formative assessment materials be needed? How will evaluation results be used in grading? Restructuring the unit? Are methods provided for informal as well as formal assessment of the unit's effectiveness?

Design of Instruction

Analyze objectives
Consider subject matter
Identify learning sequences
Plan teaching strategies
Select media/materials
Prepare lessons

The second stage of the model considers the design of instruction.

Analyze Objectives. Objectives identify the outcomes desired, but they do not always prescribe enabling skills or the development of ideas needed to accomplish a particular end. The objectives will have to be arranged in a coherent schema that will foster student understanding.

Consider Subject Matter. The topics, concepts, principles, examples, and activities needed to fill out the unit may be apparent from the objectives. Conversely, an appraisal of content may reveal gaps or overlaps in objectives that require revision.

Identify Learning Sequences. From an analysis of the objectives and the appropriate subject matter to be covered, the scope and sequence of learning activities need to be derived. Provision should be made for tailoring the scope and sequence to individual student needs as well as those of a group.

Plan Teaching Strategies. Identify possible strategies that can be employed to foster student learning. The strategies should reflect a variety of approaches and be consistent with student learning characteristics. Approaches should promote independent learning skills.

Select Media/Materials. Survey the possible media and materials available to accomplish the goals identified. Select the most effective combination of instructional methods and media indicated by the previous considerations.

Prepare Lessons. Identify and outline the specific components of daily lessons. Decide upon those behaviors or other kinds of feedback that will indicate desired learning is occurring. Specify the student activities needed to reinforce, maintain, or extend their understanding.

Evaluation

Implement
Collect/analyze results
Revise

The third phase of this model is evaluation. Evaluation should be formative as well as summative. Therefore, the results of the evaluation phase may be drawn upon continuously to revise the instructional design. Evaluation may also lead to a reconsideration of purposes.

Implement. The educational worthiness of the instructional design can only be measured in the classroom. Observe the effects and effectiveness of the lessons created. Assess how individuals and groups respond to the various components of the unit.

Collect/Analyze Results. Compile the results of formal and informal assessments. What objectives have been attained fully, partially, or not at all? Have any unexpected outcomes occurred? Decide whether unmet objectives are reasonable and attainable.

Revise. List the strengths and weaknesses of the unit. Identify obstacles to unattained objectives. If they can be surmounted, revise the design of instruction. Review the purposes. Some objectives may be too optimistic given existing constraints. Are the evaluation methods sufficiently sensitive? Check the earlier phases, identifying and remedying weaknesses. Then implement the revised learning design and evaluate anew.

The planning of instruction based upon a systems approach to technology goes beyond validation of education goals. It includes a design for a total learning situation in which appropriate resources are drawn upon and used efficiently. The system places a high priority on learner interest and motivation with provision for adjusting the rate of instruction according to individual learner needs. A basic premise is that no single set of materials will be appropriate for all learners. Some form of assistance is available from a teacher or other sympathetic and knowledgeable tutor. Ample opportunities exist for practice, reinforcement, and feedback.

The focus of educational technology is upon the design and implementation of an instructional system, not solely on instructional media. Technology is an integral component of the entire process — not an adjunct, not merely the object of study, not simply the medium.

A Citizenship Approach to the Total Curriculum

A major educational aim in the future is to develop a citizenry that is politically, economically, and scientifically literate.

—Ralph Tyler

Technology can become part of the school program in two ways. Incidental incursion takes place as courses, materials, and methods are routinely updated and technology is drawn upon as a resource. Technology in this application tends to support existing goals. Its management is compartmentalized and outcomes associated with its use are primarily content oriented. Efforts to coordinate the use of technology or to monitor the development of technology-related skills across the curriculum are minimal.

An alternative approach is to consider the skills necessary to function effectively in an information society. The curriculum is assessed as a whole as to how effectively it meets that need. Technology is considered as a major resource drawn upon to expand or restructure the curriculum to develop the targeted skills. Components for planning, managing resources, conducting staff development, and evaluating the results of instruction are integral to this approach.

The information-rich culture students live within today is characterized by a set of public and personal issues that are highly complex and technological in nature. Big institutions, sophisticated technology, and global interdependence confront citizens with an array of technology-related questions unthought of 20 years ago. Whereas imparting knowledge and information was once a primary function of education, increasing importance must be placed on process skills such as how to make sense of and use the burgeoning wealth of data pouring forth on complex topics and problems.

It is not enough simply to learn how to manipulate a particular item of technology. Nor is it sufficient merely to study the historical development or general function of a technology tool. Technology is an integral component of daily adult activities. Students need meaningful experience applying technology to accomplish tasks relevant to real world activities. They should learn how technology can be used to access information, manipulate data bases, contrast sources of information, communicate through

multimedia, and create written and visual materials. These are not knowledge level outcomes. These are process skills students will need to draw upon as contributing members of our society.

The goals and objectives set forth for integrating technology should be framed in a set of citizenship competencies that reflect those skills necessary to be functional and literate in a contemporary society. The following set of goals, adopted largely from the *Handbook of Basic Citizenship Competencies* by Richard C. Remy, is an example of such a list. Two goals have been expanded to illustrate specific technology-related objectives.

Citizenship Goals

Acquiring and Using Information

Competence in acquiring and processing information from a wide variety of sources

Assessing Involvement

Competence in assessing one's role, rights, and responsibilities in groups affecting one's life.

Making Decisions

Competence in applying critical thinking and problem solving skills in one's citizenship role.

Making Judgments

Competence in developing and using standards such as justice, ethics, morality, and practicality to make judgments about people, institutions, policies, and decisions.

Communicating

Competence in communicating ideas to other persons and to oneself.

Cooperating

Competence in cooperating and working with others to achieve mutual goals.

Promoting Interests

Competence in working within organized systems in order to promote and protect one's interests and values.

Examples of Expanded Goals

Acquiring and Using Information

The following list presents the components involved in acquiring information. Column A suggests mediums used to acquire information. Column B indicates the processes employed in obtaining that information. Column C provides examples of intended competencies.

Column A	Column B	Column C
Mediums	**Processes**	**Competencies**
1. Print media newspapers magazines journals gazettes atlases newsletters reports books maps charts	Read Distinguish Identify Discriminate Question Understand	a. Using newspapers, students will read articles to obtain background information for discussion. b. Students will be able to distinguish between various types of written information (books vs. magazines). c. Students will be able to identify the appropriate source from which to gather specific types of information. d. While reading print materials, students will be able to discriminate between the main idea and other concepts in text. e. Students will question the validity of sources they use to gather information. f. Students will understand the proper sequence to access the various types of electronic data banks.
2. Electronic communication television broadcast cable teleconference radio telephone surveys polls		

Organizing and Using Information

The ultimate goal in acquiring information is to apply and use it. The following operations indicate those further actions which must be applied before information can be successfully used in a technological society.

Column A	Column B	Column C
Mediums	**Processes**	**Competencies**
1. Knowledge banks libraries museums repositories community groups electronic data banks	Compare Clarify Conceptualize Analyze Synthesize Infer Hypothesize Reorganize Validate	a. While using magazines to gather news, students will make longitudinal and cross-sectional comparisons of the same story. b. Students will clarify discrepancies in stories as reported by various types of media. c. Using several types of charts, students will be able to conceptualize the schematics of a flow-diagram. d. Students will analyze the process of retrieving information from an electronic data bank by examining the procedure step-by-step. e. Using several types of information retrieval mediums, students will gather information on a topic and synthesize a report. f. While examining two dissimilar media reports of the same story, students will make inferences about reporter bias. g. Using television as a retrieval medium, students will make cause and effect hypotheses of the effect of an international news incident on their lives. h. Students will be able to reorganize their hypotheses of a cause and effect relationship if the findings are inconsistent. i. Students will be able to validate conclusions of a study drawn from one medium against information and findings from another.

Communicating

This list addresses the need for increased competency in communication skills. As technology brings the world closer together, the need to communicate well with others grows in importance.

Column A	Column B	Column C
Mediums	**Processes**	**Competencies**
1. Speech one to one small group recording medium	Collect/ organize Identify target Choose delivery	Regardless of the communication medium, the same processes are used. As the communicator, the student must
2. Writing friends newspapers periodicals data banks		a. collect his/her thoughts and organize them in some manner that makes sense to the audience. b. identify the target audience so that the message is presented in a manner that can be understood. c. choose a delivery medium (speech, video, radio, etc.) that best communicates the message.
3. Visual Communications television videotape computer programming		

Instruction related to these competencies should strive to bring out the process aspects and issues connected with the use of technology in citizenship tasks. Instruction should encourage reflection and self-analysis by students. Learning activities should strive to contrast and compare the strengths and limitations of technology in accomplishing differing but related tasks. The following two questions illustrate the level of outcomes intended to accomplish these aims.

"You have access, by computer, to substantial amounts of information about individuals whom you do not know. Discuss the issue of the 'right to privacy' versus the Freedom of Information Act."

"How does the reporting of a major news item vary among a nightly television news program, the daily newspaper, and a weekly news magazine?"

Expectations for education to prepare students for a rapidly changing adult role in a world dependent upon technology do not presage easy or quick solutions. A careful and learned reappraisal of the outcomes to be achieved through the curriculum and how technology can be employed to further those goals is required. Technology must be perceived in relationship to the goals as well as the means of developing skills necessary for full participatory citizenship.

Chapter III Technology, an Avenue to Change

The first real technocrat was the cave man who became disturbed because his neighbor used a crooked stick as a plow. Naturally, he thought it would put hundreds of men out of work.

—Senator William E. Borah

The confrere of technology is change. Technology alters the manner in which we accomplish old tasks and affords us the means to be able to do new tasks. Our way of thinking must be expanded in order to apply technology effectively. Technology imposes changes in our roles, attitudes, and beliefs. It dictates changes in the way we organize ourselves individually and within our systems.

Change can create disruptions for people, organizations, and processes unless dealt with properly. Left to evolutionary means, the changes brought about by technology can lead to fragmentation of curriculum, disillusionment with new ideas, and alienation of individuals. Planned for properly, changes through technology can instill new vitality into the curriculum, motivate and excite people about education, and lead to restructuring for improved effectiveness.

The view of technology we have portrayed is that it is a means and not an end. The needs for change in education come about first, through assessment of what needs to be accomplished and why. After this step is taken, technology can become the change agent for initiating new ideas, different roles, or expanded programs. It can serve as the catalyst for quickening the rate at which we respond to the need for change.

Technology and the Individual

An educated workforce learns how to exploit new technology, an ignorant one becomes its victim.

—L. Stonier

Acceptance of an innovation makes it necessary to win the good will and active involvement of other people. The approval of people at "higher" levels and the support of those directly affected by any change is essential.

Some writers (Hoyle, MacDonald, and Ruddock) suggest that the appropriate unit for innovation is the school or community rather than the individual teacher. Certainly, the need to coordinate action and support at several levels argues strongly for a change agent that encompasses a larger organizational unit.

However, it is individuals who can block the institutionalization of any effort. The needs of the individual are pivotal in determining whether technology becomes a significant part of instruction. Individuals establish the climate in which technology is applied to education, and they set the policies of the institution in which instruction occurs. Many promising innovations have gotten off to energetic and enthusiastic starts only to fizzle in the long term because of inadequate concern for the needs of or impact on individuals.

Technology cannot achieve the desired ends unless there is a shared view of what is to be done and how it is to be done. One means to initiate that shared view is to establish broad tenets concerning the practice of educational technology. Knowing what research and experience have shown about the use of educational technology can break down preconceived notions and expand the perspectives of those who will be involved.

Tenets

- Instructional media systems can teach content as well as traditional instruction, and sometimes media can do it better.
- The design and production of high quality instructional media systems are costly and can be justified only if large numbers of learners will use these materials for long periods of time.
- Adoption of large-scale instructional media systems radically changes curriculum decision-making and instructional management structures.
- Large-scale applications of instructional media systems change the roles of teaching personnel.
- Effective use of educational technology depends on shifting the focus from thinking about instruction to thinking about what learners are supposed to accomplish as a result of instruction.
- Pupil support mechanisms must be built into learning systems that rely heavily on instructional media. (Stakenas, 1982, pp. 48-50)

The less disruptive an educational change is to current practices and attitudes, the more chance it has of being adopted. The use of technology as an instructional tool is more readily accepted than new curriculum materials or purposes. Technology applications that require changes in organizational structures or that define new roles for educators are the most difficult to implement.

Changing Roles

Proponents of educational change are sometimes inattentive to social interactions and personal relationships that influence whether a new system or medium is successful or not. For example, the provision of alternative learning approaches through technology changes the roles and responsibilities of students and teacher. Students are expected to become more active, more self-directional, and more responsible (McBeath, 1982, p. 6). Studies show that many learners do not possess the self-management skills to capitalize upon the individualized, self-paced aspects of a technology curriculum. Attrition rates, failure rates, and deviant behavior, such as cheating and vandalism, increase when a caring human mentor is not present (Stakenas, 1982, p. 50).

In a technology curriculum the adjustment for the teacher may be even more pronounced than that for students. The teacher assumes a less central role, serving as the resource person and manager of instruction rather than the primary dispenser of information. Many individuals will tend to resist any technological innovation simply because it partially removes them from the traditional role of delivering the instruction. Educational technology identifies student learning as the desired end, putting the focus on the results of instruction. Teachers must identify an acceptable role for themselves within a new framework. It is vital that supervisors assist teachers in finding satisfying features in a technology-related role to replace those characteristics enjoyed in their previous assignments.

At certain times in his life, each man is tempted to become a Luddite, for there is always something he would like to go back to. But to be against all change—against change in the abstract—is folly.

—James A. Michener

Some teachers may understandably view efforts to incorporate technology as threats to their job security. They may fear to be found wanting in

being able to learn those new ideas required or to adjust to a different set of expectations. Though wishing to be part of curricular changes or applications of technology, they may elect the safer course of trying to maintain the status quo or adopting the insular attitude that "new things" are the responsibility of a "specialist." These teachers will require assurance and assistance to quell their unspoken but very real anxieties.

Security is high on the list of human needs. In our exuberance to share our visions of the potential of technology, we need to be sensitive to those who are not as confident about their roles in emerging plans.

Inservice

Incorporating technology into the curriculum requires carefully structured and expanded inservice opportunities. Planning for inservice training should consider the management and development needs of staff in implementing a new technology. Teachers will be expected to manage a different set of instructional resources than those to which they are accustomed. Resources need to be woven into instructional units consisting of well-defined objectives, suitable activities, and appropriate evaluation plans. Expectations may easily exceed teachers' previous training or skills.

Such needs cannot be addressed in one or two inservice sessions. Carefully developed timelines and goals for staff development should become part of an accepted school or district plan before inservice training begins. Those changes which people support most fully are ones in which they truly believe. But belief comes only over a period of time and through experiences that convince the individual of the value of the change.

If the stability of the present teaching force is to be maintained, there must be a careful assessment of how the district can assist staff members to develop the expertise that is needed to incorporate innovations. American industries routinely allocate an amount equal to 5%-10% of workers' salaries for the purpose of retraining. Boards of education may need to consider comparable alternatives for giving release time or financial assistance to currently employed staffers to obtain the necessary training for new programs. This training may consist of on site inservice or extended study at another institution. Such efforts will assist in updating the skills of the staff over a period of time.

Innovative Climate

An important step in helping the individual adjust to change is setting the climate for innovation. A school or district which continually experiments, tries new programs, and updates its curriculum will find individuals more receptive to changes of all types than one which waits for outside pressures to force changes.

In establishing a climate for innovation, school officials should provide opportunities to explore different approaches that incorporate technology. One does not become an "instant expert" overnight. Professional meetings, informational literature, guest speakers, and pilot materials should be priority targets that are the specific assignment of a person charged with staff development responsibilities. This person, operating from defined district goals for integrating technology, should review faculty strengths and weaknesses in these areas and implement specific plans for developing the needed expertise.

To use any technology effectively, an individual needs a period of time to become acquainted with its capabilities, limitations, and requirements for changing the management of instruction. Too often, the push to incorporate innovative material or equipment comes before individuals have a chance to become familiar with the items themselves. Many administrators have had success in sending equipment home with teachers over the summer before a planned implementation in the fall. Other administrators have given new program materials to teachers a semester early with encouragement to try out aspects of the program in their current classes.

Informal exploration gives the participating individuals the opportunity to work with the innovation in a nonthreatening environment with a particular population. Given this introductory time, teachers can think through the kinds of changes that will be necessary in their programs or methods in using the innovation full time. Without the pressures of implementation, their creative thinking is less impeded by the press to develop new teaching plans each day. This period gives educators the time to make the innovation their own.

Institutionalization

Attempts at educational innovation are sometimes hamstrung from the outset by inadequate commitment in the form of funding, support personnel, organizational restructuring, support materials, and long-range planning. Institutionalization usually goes on for months or years before a new technology successfully takes root. Support mechanisms that provide adequate materials for incorporating change and the means for rejuvenating the initial excitement and enthusiasm are practical matters that should not be overlooked. Unanswered problems are the simplest excuse to tip the individual's decision toward the "tried and tested" approaches.

One of the most difficult obstacles to effective use of instructional technology is that of diffused decision making in public education. Educators take pride in and value their autonomy in developing instructional activities for students. Yet the incorporation of a systems approach requires careful planning, joint decision making, and cooperation from members of the educational community who have not traditionally worked together in such roles. No plan for innovation should proceed without giving careful attention to the changing roles of participants. This may require organizational changes within the institution.

Documented Barriers to Implementing an Innovation

- Teacher's lack of clarity about the innovation.
- Teacher's lack of skills and knowledge needed to conform to new role models.
- Unavailability of required instructional materials.
- Incompatibility of organizational arrangements with the innovation.
- Loss of staff motivation.

(Neal, et al. 1981 in Rowntree, p. 237)

Technology and the School

No changes in an educational system will be of any significance unless the social organization of education is totally changed, that is, unless the system itself is changed. Nothing else will do, for it is the whole system that defines the nature and function of the parts.

—John Bremer

A commitment to integrating technology must occur at two levels if it is to be effective—the point of instruction and the operation of the school. All too frequently the message of the classroom is lost if students witness a different level of technology in the school operation. Outcomes associated with technology must be viewed in a much broader framework than merely the direct instruction that is part of a course.

Matching Goals to Curriculum

The most important means of achieving a unified educational message on technology is to have a district and school plan. This plan should consider technology in the total operation of the school. A framework spelling out the philosophy of the district and translating that philosophy into broad goals is needed to give direction to the total curriculum and general school operation.

Application of technology is pervasive throughout the total school environment. Scheduling, record keeping, grade reporting, and communications are daily activities that require the use of technology. Cataloging, printing, and financial transactions are carried out with the assistance of technology. Guidance, food, and health services draw upon technology in their provision. Maintenance, transportation, and sports training utilize technology to do a better job.

These aspects of the school make up the hidden curriculum. They are as important in preparing students for the use of technology as the stated curriculum. When the activities of the hidden and stated curricula do not match, a student is left questioning the soundness of the educational experience. It is shortsighted to teach students word processing skills and then have them work as assistants in the office or library in which outdated typewriters are employed. It is anachronistic to restrict students' library experiences to card catalogues and print forms of information when public and university libraries use electronic retrieval systems, microfilm, and microfiche.

A mixed message is also received when students are prohibited from using technology in ways generally accepted outside the school. Students are understandably confused when they receive no direct instruction in the use of calculating devices (or are denied access to them), but then witness their educators and parents draw upon such devices almost exclusively for their own numerical tasks.

Utilization

The high cost of technology makes it imperative to get the maximum use of hardware and software. A $20,000 printing machine may be difficult to justify instructionally if only 15 students are served during two days of direct instruction in its operation. However, if that machine can be used for a wide variety of school printing tasks, its purchase can be justified by the number of educationally related tasks in which students gain experience.

Similar cost-effectiveness arguments arise if only one department (or teacher) of the school is perceived to have "ownership" of particular technology hardware (or software). The equipment is likely to sit idle during portions of the day when it could be in use. The choice to locate multiple units in a laboratory setting or to make them available to teachers upon request from the media center, can be a difficult one. The laboratory has the advantage of making it easier to provide large group instruction. However, the units usually become permanently affixed (physically or through scheduling). This restricts access to the units and makes single unit use for demonstration or class discussion very difficult. Some combination of laboratory plus mobile units is probably the best answer for pieces of technology which can be used throughout a building. The key is to provide for the optimum use of the units and to avoid unreasonable expenditures.

Consideration may also need to be given to extension of school hours to give students and others the opportunity to use the technology according to their needs. Community and adult education is important in this planning. The newness of a technology addition to the curriculum will often be matched by a community need for education in the same area. Part of the district plan should be concerned with ways in which to meet this responsibility. Such scheduling can help justify the expenditure of costly items in addition to being an asset in creating positive public relations.

The application of technology to the school's curricula is so broad that is is unrealistic for a single teacher or department to have the responsibility for its management and coordination. The impact of technology on students' education and preparation for applying technology in their adult roles is so significant that it should not be left to chance or the single perspective of a particular grade or discipline. To govern the multiple functions and roles that technology plays, a comprehensive district or school plan with well-defined objectives should be put together by a committee of people working on its development and toward its continuing implementation.

Costs

According to David Ahl of AT&T (Seidel, 1977), administrators tend to view technology as a means of controlling costs and do not perceive it as an extension or means of doing something new. Cost-effectiveness arguments may be arguable for the application of technology to administration. However, they are not persuasive for the delivery of instruction, excepting for very large systems such as instructional television broadcasting. Evidence does not exist to advance arguments for replacing teachers with technology, or even for replacing textbooks (Hawkbridge, 1983, p. 179).

Incorporating technology within the curriculum must be sold to a supporting public on the basis of the importance of the ends which can be achieved in its use. There is no skirting the issue that technology is expensive. Moreover, the initial or start-up expenses may be just part of the iceberg compared to eventual costs that include supporting materials, maintenance, and curriculum and staff development expenses. This factor underscores the need to have well-defined outcomes, long-range planning, and full utilization of resources.

To build the support for technology costs, some re-education of the public can be helpful. Compared to the average outlay for equipment for workers in other occupations, the educator is at a decided disadvantage.

The average industrial worker is said to have $25,000 worth of equipment for his job; the average agricultural worker, $60,000 worth; and the average office worker, $2,000 worth. But the average teacher has even less, about $1,500 worth.

—Joseph Robertson

Educators should be adamant about the importance of adequate funding to accomplish technology objectives. Budgetary items which have heretofore been modest may have to be sizably increased. Outlay for equipment should be viewed as only a portion of the total costs. Costs for supporting software and other materials should not be judged by textbook or other print standards. The history reinforced lesson that most innovations fail due to inappropriate support should not be ignored.

Technocracy

These microprocessors execute 500K instructions/second with a memory density of 5M bits/in for a 8192-bit chip which dissipates 25 milliwatts with a 90 nanosecond access time.

The foregoing is a classic example of technobabble, the language spoken by technocrats to impress other people and influence decision making through intimidation. Among those experienced with technology, there is a tendency to be insensitive to the effect of technological jargon on those who are less experienced. In some instances, this effect is unintentional as the speaker is swept up in his own thinking and not attuned to the needs of his listener. At other times, such practice is overt, predicated on the maxim that knowledge is power.

The effects of technobabble are so negative that it is important to nip this practice early. Speakers or inservice leaders who are going to introduce technology to inexperienced faculty should be cautioned about the jargon they use. Everyone is reluctant to disclose lack of understanding about technology, particularly if it is perceived to be below the level of general discussion. It is therefore important for those who are secure in their positions to initiate questioning. "Frankly, some of the terminology is over my head. Can you restate the point concerning..."

Technocracy takes a more subtle form within the institution. In implementing technology within a building or in planning for its integration at the district level, there is a danger that those well-versed in technology will be perceived as wielding an inordinate amount of influence. Necessarily, the application of technology will require a redistribution of some district resources, demanding the input of knowledgeable people. Those with technology expertise are likely to be younger, more energetic, verbally enthusiastic, and newer to the staff than other faculty groups. A very subtle form of resistance to change can easily ensue if "old guard" representation

from the faculty and administration is not equal to that of the "young turks." Committees for implementing technology changes in the district should therefore not consist solely of those with "high-tech" expertise.

Addressing this concern can have added advantages beyond the obvious political pluses. Those who are not strong advocates of technology are more likely to identify obstacles and future problems. They are more knowledgeable about people factors and organization structures that will be affected by change. Expertise begins to suffuse and along with it cooperation and support. Most critically, no sharp shift in power structures within the organization will be discerned.

Measured Response

Our little systems have their day; They have their day and cease to be.

—Alfred Lord Tennyson

Estimates of the time required for education to accommodate significant past changes range from 20 to 40 years. The pace with which technology is measurably reshaping our daily lives suggests that education cannot afford such conservative change processes in the future. The time is insufficient to allow research and validation studies to point out clearly how particular innovations should be employed.

Yet, we must also be alert to the dangers of overreacting and instituting sweeping changes that will be short-lived or unnecessarily expensive. While acknowledging the potential of technology, we must not be so captivated that we fall prey to the quick solution. Planning for a microcomputer in every classroom may seem very appealing, but is it a wise utilization of resources? What evidence suggests that every student needs exposure to programming languages? Will a literacy course required of all students for graduation be relevant five years from now?

The answer to these and other appropriate questions can only come through solid curriculum development that carefully examines the need for program revision, weighs implications for the instructional process, and targets specific goals and outcomes to be addressed. As a reasonable starting point, we have advocated the identification of skills needed for effective citizenship. This approach has the advantage of not allowing existing programs or structures to hinder our perspective. It strikes quickly to the heart of what we are hoping to accomplish and why. It elicits

thought provoking questions. It avoids premature consideration of issues such as cost effectiveness.

However, the keystone to keeping abreast of technology is a curriculum change mechanism that incorporates shared decision making, broad-based community representation, and vigorous leadership. The persons who implement the changes in the curriculum need to become more involved in making the decisions for change. Their support and commitment will be stronger if they have some control over the changes that are proposed.

At the same time, decision making at the instructional level has to become less autonomous and subject to more group involvement. Input from the community should be ongoing to assure that the curriculum is appropriate for meeting its stated goals. Expertise and resources must be shared to provide educational experiences that match the needs of educated citizens. Leadership is required at each level to manage such a dynamic educational setting. Progress should be neither quick nor slow. It needs to be measured, well defined, and ongoing.

Real Literacy

For thousands of years the craft of reading and writing remained the sacred monopoly of small elites. By 1750 at the dawn of the Industrial Revolution, almost 5,000 years had elapsed since the first rudimentary appearance of the art of writing. Yet, more than 90 percent of the world's population had no access to the art.

—Carlo Cipolla

As we prepare students to enter the 21st century, we must be pledged to the kind of literacy for all students that will permit them to be happy, productive members of a technology-oriented society. We must curb curriculum decisions and instructional planning that serve only a high-technology minority. So must we also avoid discouraging individual interests and aptitudes through overstandardization of curriculum. No student should be limited in adult society by his or her education.

To accomplish this goal, technology needs to be integrated fully within the curriculum. It should be merged with other related content and open new areas for study. It should facilitate learning and help to promote independent learning skills. For each individual, technology must be used to open doors, not to delimit opportunity.

Our educational programs must be conducive to change to keep pace with the rest of society. Moreover, that change must be reflected throughout the total curriculum. Technology should be used to further the democratic principles upon which American education is based. That can only be accomplished through full literacy for every student.

Leadership

New and revolutionary teaching methods are constantly being thrown-up. Not often by teachers, who are far too busy in the classroom, but by others who see their ratings in the educational charts slipping and who need to claim the public eye. These methods normally have but a brief life and are seldom adopted in-depth, so don't bother with lengthy courses of instruction. However, it is well to know what they are all about—the elements are quickly assimilated along with the relevant vocabulary. Used while the method is enjoying its brief vogue, it gives a pleasing up-to-date impression.

This excerpt from Taylor (1969), *A Bluffer's Guide*, unfortunately characterizes too many past efforts at educational change. Educational institutions are by their nature resistant to change. At best, many innovations are blunted by educators who adopt only those features which fit comfortably within the existing system. There has even emerged a certain survival instinct in being cynical toward the plethora of untested fads and fancies which constantly assail education.

Conversely, high technology has captured the imaginations of persons across Ohio from legislators to school board members to parents. The bright promise of high-technology jobs and the seemingly unending supply of inexpensive high-technology devices have encouraged people to look to technology for the solutions to many problems besetting society. The expectation that education will incorporate technology into instructional programs runs equally high. The challenge to education decision makers is to respond to this high expectation in the face of forces that are resistant to change.

Solid educational leadership is the key to making educational technology work. New hardware and software must be studied and understood. New approaches to providing and managing instruction must be developed. Perceptions must broaden to include study skill targets appropriate

for an information-rich society. Roles within the classroom and institution must undergo significant changes. Staff development must become an ongoing, important, and desirable aspect of one's profession, linked to classroom operation. Evaluation, planning, and revision must become the basis for keeping the curriculum responsive to a dynamic society.

It is naive to expect changes of this magnitude to occur in a short interim. It is shortsighted to believe that these events can take place without significantly changing the makeup of educational institutions. As schools emerge from fiscal travail, they face the challenge of curriculum credibility. Leadership at all levels is vital in assisting schools through this growth period.

Curriculum directors, principals, supervisors, head teachers, and department chairpersons need to become increasingly active in working with other staff members to manage technology effectively. Hesitant teachers need to be nudged along. Uncertain staffers need support and guidance. Fervor requires channeling and direction. Utmost in importance is the need to involve all concerned individuals in the change process, according to a schedule they feel comfortable with, one which recognizes and contains provisions for their needs.

A visionary leadership is necessary from the top administration of a district which recognizes the broad nature of technology and the goals attainable with it. This leadership must be able to conceptualize the outcomes necessary for preparing students for full citizenship in a high-technology world. It must be able to translate these understandings into planning and organization for attaining these goals. It must be able to garner support from the community and tax-paying public to maintain these efforts. It must recognize the length of time and the social considerations required for significant change. This leadership must exhibit commitment, patience, and follow-through to realize its goals.

Chapter IV The Future

The only limit to our realization of tomorrow will be our doubts of today.

—Franklin D. Roosevelt

The size of the information explosion in the United States in 1981 was estimated by Robinson (p. 62) at 30 billion original documents created each year, 630 billion pages of print sent through the postal system, and 100 billion pages reproduced on photocopiers. This is equivalent to four additional filing cabinets of paper for every employed person, with the paper stretching twelve miles if laid end to end. These figures were expected to double within five years.

Such statistics are numerical indicators of the manner in which technology is changing our personal lives, our jobs, and our education. But they are really only harbingers of what is to come. Technology is an emerging area which we are only beginning to tap. Ultimately, technology will change the fundamental structure of our institutions and redefine the roles we play in those institutions.

As education moves forward to adapt to the changes that technology will bring, we might reflect upon the nature of the changes we expect in the near future.

Focus on Process

Current emphases on technology in education are probably best characterized by hardware acquisition and experimentation. As the pressures ease to acquire hardware units and as classroom personnel become more familiar with the capabilities of those units, we can expect greater attention to the fundamental ways those units will change the instructional system.

The first stage of this shifting awareness will be a realization that teaching about technology as a tool (literacy) or offering stand-alone programs (robotics) is only meeting a temporary need. As goals are established for the application of technology to prepare students for citizenship, the importance of integrating technology within the existing curriculum will be realized and with it the altering of that curriculum in the process.

The second stage will be a review of the ways in which technology should be used as educators understand better the potential for exploiting the special strengths of technology to accomplish tasks in entirely new ways. Inappropriate or inefficient applications of technology will receive careful review as we respond to critics about the way our educational resources are being used.

There are better, more sensitive ways to use computers than using computer exercises to replace flashcards and spelling books. We are staying away from computer-assisted instruction because most objectives can be reached without computers. We should take advantage of those parts of information technology which you cannot reach with traditional methods.

—Peter Gorny
West German computer professor

Phase three will begin with an examination of questions concerning what is fundamental to education, what should be retained, what should be changed, and what the best means are for providing education.

Thought-provoking, difficult issues will emerge:

- Why is deliberate education necessary?
- What is to count as worthwhile knowledge?
- Who should decide subject content and objectives?
- Can we avoid emphasizing trivial but easily measurable outcomes?
- Do learners need teachers?
- Can learning be both personal and prepackaged?
- Should students be expected to adjust to instruction, or vice-versa?
- How dare we allow any student to fail?
- Is it fair to label students with grades? to what purpose?
- How can we determine whether instruction achieves anything of lasting value?
- How much education is each student entitled to?
- How can programs be continuously improved?
- How should decisions like these be made?

(Rowntree, 1982, pp. 245-6)

Deliberations on issues like these will produce significant changes. We can expect more self-paced courses and loosening of time constraints on a fixed curricula. Courses will not necessarily begin and end only at semester intervals. New attitudes will foster changes in evaluation, with more emphasis on competency-based grading. The public school institution will not necessarily be restricted to populations of students five to eighteen years of age. The number of adult Americans involved in some form of training or education (currently 64 million a year) will increase markedly as adults come to expect public schools to offer convenient means for their continuing education.

Significantly, there will be a deliberate priority given to providing each student with those skills necessary for keeping career opportunities open. Technology will be perceived as a means for democratizing the schools in terms of opportunity rather than as a force which will splinter the student body into high-tech, high-promise and limited skill, low-expectation factions.

Peopleware

Future shock...the shattering stress and disorientation that we induce in individuals by subjecting them to too much change in too short a time.

—Alvin Toffler

Terry Rosenfeld, a New Jersey educator, has coined the term "peopleware" to emphasize how crucial concerns of the individual are in implementing technology within the school. His experiences as a computer program coordinator underscore the potential for negativism, fear of automation, and concern for jobs that teachers have in acclimating to technology.

As schools begin to incorporate technology into the curriculum on a larger scale, there will be a growing understanding of the need to plan for the human element in the change process. Careful planning with appropriate timelines for introduction of technology will ensue. Staff development experiences will grow substantially in importance and dimension, assuming structures appropriate for the specific technology-associated need. School boards, administrators, and teachers will each come to value on-the-job training more highly, creating mechanisms and incentives for improved teaching skills.

As schools appreciate the fact that changes will become an inherent feature of an up-to-date curriculum, there will be further organizational shifts to provide the leadership, means, and support to accomplish these changes. There will be a growing partnership between teachers and administrators in the design and execution of systems of instruction. Each will be assuming altered roles in which new elements for job satisfaction will need to be identified and accepted.

The design and execution of instruction will be substantially broadened to include the expertise of the community. Input from the private sector will be ongoing in accordance with the appropriateness of the curriculum and the changing job skills desired. Community resources and personnel will become ever more important in providing a rich set of instructional experiences that the tax-paying public can support.

Learning Outcomes

Computing machines perhaps can do the work of a dozen ordinary men, but there is no machine that can do the work of one extraordinary man.

—E. B. White

What kinds of skills are needed to be productive in the next century? They surely will not be those which can be done by inexpensive devices or which are easily outdated. Technology brings to the curriculum and to the individual extended capabilities that require different sets of personal skills to manage and use effectively. We can predict quite easily the need for more emphasis on thinking skills and less on mechanical technique. We know that individuals will have to acquire better self-management skills and the ability to choose from a variety of resources. They will have to become proficient at handling and accessing large amounts of information.

Students will also need to acquire the capability to adjust to new situations and expectations. By necessity, education will be a life-long experience that will not terminate with a high school diploma. On-the-job training, self-learning, and learning associated with recreation and culture will be ongoing. To access the multiple resources available for these purposes, students will need to possess independent learning skills and attitudes.

The 3R's will take on substantially new forms in a technology-rich curriculum, but what of other courses that deal with values and which transmit the important aspects of our culture from one generation to another? Obviously, they will draw upon technology in their instruction. Equally apparent is their continuing importance to the individual in the future. Life-course skills like cooking, home management, and health are just as vital in a high-technology society as in our present one. Music, art and physical education components of the curriculum cannot be shunted aside in favor of new technology courses—computer science, computer literacy, word processing.

Tomorrow's society will make great demands on individuals that will tax their resources in thinking and adjusting. Individuals will require a solid grounding in personal and interpersonal skills, self-perception, sense of values, and acceptance of their culture to be able to function effectively in a climate of rapid change. Individuals will have a wide array of technological applications at their command, but it will not diminish in any respect the importance of education in preparing them to use those applications wisely and meaningfully.

The future offers very little hope for those who expect that our new mechanical slaves will offer us a world in which we may rest from thinking. Help us they may, but at the cost of supreme demands upon our honesty and our intelligence. The world of the future will be an ever more demanding struggle against the limitations of our intelligence, not a comfortable hammock in which we can lie down to be waited upon by our robot slaves.

—Norbert Wiener

Conclusion

The challenge and opportunity facing education in the coming years are considerable. Changes will be necessary that at best will be discomfiting and at times painful. Whether the traditional formulae of increased standards, improved teacher training, and better pay will be sufficient for addressing the needs associated with education in an information society is questionable. If the changes in our society are as great as some predict, such efforts are not likely to be enough. Technology offers us the means to create a new variety of learning environments. It gives us the opportunity to provide students with greatly expanded skills and capabilities. Realization of this promise will depend, in large measure, upon the resourcefulness of educational leadership in planning for change (Deringer, 1983, p. 111).

Glossary

ALGORITHM: AN ORDERLY STEP-BY-STEP PROCEDURE, LIKE A RECIPE, THAT CONSISTS OF A LIST OF INSTRUCTIONS FOR ACCOMPLISHING A DESIRED RESULT, OR FOR SOLVING A PROBLEM.

BASIC: AN ACRONYM FOR BEGINNERS ALL PURPOSE SYMBOLIC INSTRUCTION CODE. A HIGH-LEVEL CONVERSATIONAL, INTERPRETIVE, PROGRAMMING LANGUAGE. IT PERMITS THE USE OF SIMPLE ENGLISH WORDS AND COMMON MATHEMATICAL SYMBOLS TO PERFORM THE NECESSARY ARITHMETIC AND LOGICAL OPERATIONS TO SOLVE PROBLEMS.

BAUD: A RATE OF INFORMATION FLOW. GIVEN IN BITS PER SECOND (BPS), THE RATE IS THE HIGHEST NUMBER OF SIGNAL ELEMENTS (BITS) THAT A DEVICE IS CAPABLE OF TRANSFERRING IN ONE SECOND BETWEEN TWO DEVICES. ALPHABETIC CHARACTERS, FOR EXAMPLE, BEING TRANSFERRED AT 300 BAUD CORRESPONDS TO ABOUT 30 CHARACTERS PER SECOND. COMMON BAUD RATES ARE 300 AND 1,200 BPS.

BINARY CODE: CODE USING ONLY ZERO AND ONE TO REPRESENT DATA.

BIT: BINARY DIGIT. THE SMALLEST UNIT OF DIGITAL INFORMATION. IT HAS ONLY TWO STATES: ZERO AND ONE. A BIT CAN BE THOUGHT OF AS REPRESENTING A YES/NO CHOICE, A DISTINCTION BETWEEN TRUE AND FALSE, OR WHETHER A CIRCUIT IS ON OR OFF.

BRANCH: A PLACE IN A PROGRAM WHERE A CHOICE IS MADE TO DEPART FROM THE NORMAL SEQUENCE OF PROGRAM INSTRUCTIONS. THE DEPARTURE IS MADE BY A "BRANCHING INSTRUCTION" IN THE PROGRAM. A BRANCHING INSTRUCTION MAY BE ONE OF TWO TYPES: CONDITIONAL OR UNCONDITIONAL. IN BASIC, AN EXAMPLE OF THE FIRST TYPE IS: IF...THEN; OF THE SECOND TYPE IS: GO TO.

BUFFER: A SPACE IN A COMPUTER SYSTEM WHERE INFORMATION IS TEMPORARILY STORED. USUALLY USED TO STORE SMALL SECTIONS OF DATA DURING A TRANSFER PROCESS. FOR EXAMPLE, DATA MAY BE READ FROM A TAPE CASSETTE IN SMALL UNITS, PLACED IN A BUFFER, THEN TRANSFERRED TO MAIN MEMORY WHEN THE COMPUTER IS READY TO PROCESS THE DATA.

BYTE: THE BASIC UNIT OF INFORMATION IN A COMPUTER. COMMONLY CONSISTS OF A SEQUENCE OF EIGHT BINARY BITS, USUALLY HANDLED AS A UNIT. ONE BYTE USUALLY REPRESENTS ONE CHARACTER.

CHARACTER: SINGLE ITEMS THAT CAN BE ARRANGED IN GROUPS TO STAND FOR INFORMATION. THERE ARE TWO FORMS:(1) NUMBERS, LETTERS, GRAPHIC SYMBOLS, ETC., THAT CAN BE UNDERSTOOD BY HUMAN BEINGS, AND (2) GROUPS OF BINARY DIGITS THAT CAN BE UNDERSTOOD BY THE COMPUTER.

CHARACTER SET: REFERS TO THE CHARACTERS AVAILABLE TO A COMPUTER, PRINTER, OR TERMINAL. SOME DEVICES HAVE ONLY UPPER CASE LETTERS PLUS NUMBERS AND A FEW SPECIAL CHARACTERS SUCH AS PUNCTUATION, 1, ETC. OTHERS HAVE UPPER AND LOWER CASE LETTERS, NUMBERS, AND MANY SPECIAL CHARACTERS WHICH MAY BE COMBINED TO FORM DESIGNS.

CHIP: A PIECE OF SILICON ON WHICH THOUSANDS OF ELECTRONIC ELEMENTS ARE IMPLANTED. CALLED A MICROPROCESSOR, IT CONTAINS ALL THE CIRCUITS ONE NEEDS TO CARRY OUT THE MANY COMPUTER OPERATIONS.

COMMAND: AN INSTRUCTION GIVEN TO THE SYSTEM THROUGH AN INPUT DEVICE OR PERIPHERAL. IT IS EXECUTED AS SOON AS IT HAS BEEN RECEIVED.

COMMUNICATIONS SATELLITE: RECEIVES SIGNALS FROM POINTS ON EARTH AND RETRANSMITS THEM DOWN TO OTHER POINTS. ORIGINATING SIGNALS COME FROM UPLINK SITES AND RECEIVING POINTS ARE DOWNLINK SITES.

COMPUTER: A DEVICE THAT RECEIVES AND THEN FOLLOWS INSTRUCTIONS TO MANIPULATE INFORMATION. THE SET OF INSTRUCTIONS AND THE INFORMATION ON WHICH THE INSTRUCTIONS OPERATE ARE USUALLY VARIED FROM ONE MOMENT TO ANOTHER. IF THE INSTRUCTIONS CANNOT BE CHANGED, THE DEVICE IS NOT A COMPUTER. THE DIFFERENCE BETWEEN A COMPUTER AND A PROGRAMMABLE CALCULATOR IS THAT THE COMPUTER CAN MANIPULATE TEXT AND NUMBERS; THE CALCULATOR CAN MANIPULATE ONLY NUMBERS.

CPU: CENTRAL PROCESSING UNIT. THE HEART OF THE COMPUTER, CONTROLLING WH AT THE COMPUTER DOES. IT INCLUDES THREE MAIN SECTIONS: ARITHMETIC, CONTROL, AND LOGIC ELEMENTS. IT PERFORMS COMPUTATIONS AND DIRECTS FUNCTIONS OF THE SYSTEM.

CRT: ACRONYM FOR CATHODE RAY TUBE. SIMILAR IN APPEARANCE TO A TELEVISION SCREEN.

CURSOR: MOVABLE INDICATOR ON CRT TO INDICATE A SPECIFIC CHARACTER OR SPACE THAT IS BEING DISPLAYED.

DAISY WHEEL PRINTER: A PRINTER WHICH HAS A WHEEL MECHANISM, WITH CHARAC TERS ON THE PERIMETER OF THE WHEEL. THE WHEEL ROTATES TO PLACE THE APPROPRIATE CHARACTER IN PRINT POSITION. A "HAMMER" STRIKES THE CHARACTER, FORCING IT AGAINST A RIBBON, THEREBY FORMING AN IMPRESSION ON THE PAPER. THE DAISY WHEEL PRINTER HAS THE REPUTATION OF GREAT RELIABILITY, IS RELATIVELY INEXPENSIVE, AND FORMS A SOLID CHARACTER ON THE PAPER.

DATA: THE INFORMATION GIVEN TO OR RECEIVED FROM A COMPUTER.

DATA BASE: FILE OF INFORMATION, ABSTRACTS, OR REFERENCES ON A PARTICULAR SUBJECT OR SUBJECTS.

DEBUG: PROCESS OF FINDING, LOCATING, AND CORRECTING MISTAKES OR ERRORS IN A PROGRAM.

DIRECT BROADCAST SATELLITE: CAPABLE OF COMMUNICATING PRINTED AND AUDIOVISUAL INFORMATION BETWEEN TWO OR MORE PLACES WITHOUT USING INTERMEDIATE LAND LINES.

DISC (DISK): A RECORD-LIKE MAGNETIC-COATED PIECE OF MATERIAL THAT CAN S TORE PROGRAMS, DATA, OR TABLES OF INFORMATION. THE PROCESS IS SIMILAR TO STORING MUSICAL INFORMATION ON A MAGNETIC TAPE. COMMONLY FOUND ARE FLOPPY AND HARD DISC SYSTEMS.

DOCUMENT: A WRITTEN DESCRIPTION OF A PIECE OF SOFTWARE OR HARDWARE. IT CAN ALSO BE USED AS A VERB WHICH IS THE PROCESS OF PRODUCING SUCH A DESCRIPTION.

DUPLEX: PROCESS OF SIMULTANEOUS TRANSMISSION IN TWO DIRECTIONS.

EDITOR: A PROGRAM WHICH ALLOWS CHANGING, MODIFICATION, OR MOVEMENT OF PROGRAMMING STATEMENTS. IT ALLOWS THE PROGRAMMER TO WRITE AND MODIFY INSTRUCTIONS USING THE MICROPROCESSOR AND A TERMINAL AS A VERY SOPHISTICATED TYPEWRITER.

EXECUTE: TO CARRY OUT AN INSTRUCTION OR PERFORM A ROUTINE.

FLOPPY DISC (DISK) DRIVE: A DEVICE FOR STORING INFORMATION ON A FLEXIBLE METALLIC-COATED PLASTIC DISC SIMILAR TO A 45 RPM RECORD.

HARDCOPY: DATA OR INFORMATION PRINTED ON PAPER. USED TO DISTINGUISH BETWEEN PRINTED INFORMATION AND THE TEMPORARY IMAGE FOUND ON THE CRT.

HARDWARE: THE PHYSICAL EQUIPMENT THAT GOES INTO A COMPUTER SYSTEM, CONSISTING OF THE CENTRAL PROCESSING UNIT PLUS ALL PERIPHERALS.

IC: INTEGRATED CIRCUIT. A PLASTIC OR CERAMIC BODY FIVE CENTIMETERS LONG, TWO CENTIMETERS WIDE, AND THREE MILLIMETERS THICK WITH UP TO 40 LEADS EXTENDING FROM IT. INSIDE THE BODY IS A CHIP. THE BODY PROTECTS THE CHIP, AND THE LEADS ALLOW ELECTRICAL CONNECTION OF THE CHIP TO OTHER COMPONENTS. THE WORD "CHIP" IS NOT USED TO REFER TO THE ENTIRE IC.

INPUT: INFORMATION GOING INTO THE COMPUTER OR INTO A PERIPHERAL.

INTERFACE: A COMMON BOUNDARY BETWEEN DATA PROCESSING SYSTEMS.

I/O: INPUT/OUTPUT OF INFORMATION IN A COMPUTER SYSTEM. EXAMPLES OF I/O DEVICES ARE: A KEYBOARD, A FLOPPY DISC DRIVE, AND A PRINTER.

KEYBOARD: A DEVICE FOR TYPING INFORMATION INTO A COMPUTER. IT IS SIMILAR IN DESIGN AND FUNCTION TO A TYPEWRITER KEYBOARD. THE COMPUTER KEYBOARD HAS SEVERAL ADDITIONAL KEYS FOR SPECIFIC COMPUTER FUNCTIONS.

K OR KILO: SYMBOL OR SUFFIX FOR 1,000. IN DEALING WITH COMPUTERS, 1K IS USED TO MEAN 1,024. A COMPUTER WITH 32 BYTES OF MEMORY MEANS THAT IT HAS 32 TIMES 1,024 BYTES OF MEMORY.

LANGUAGE: A LANGUAGE IS A DEFINED GROUP OF REPRESENTATIVE CHARACTERS OR SYMBOLS, COMBINED WITH SPECIFIC RULES NECESSARY FOR THEIR INTERPRETATION. THE RULES ENABLE AN ASSEMBLER OR COMPILER TO TRANSLATE THE CHARACTERS INTO FORMS (SUCH AS DIGITS) MEANINGFUL TO A MACHINE, SYSTEM, OR A PROCESS.

LOGO: A HIGH LEVEL PROGRAMMING LANGUAGE ORIGINALLY DESIGNED FOR USE BY YOUNG CHILDREN. LOGO IS A MODULAR, GRAPHICAL, INTERPRETING SYSTEM.

LUDDITES: GROUPS OF WORKERS IN ENGLAND (1811-1816) WHO TOURED DISTRICTS AROUND NOTTINGHAM, WRECKING NEW WEAVING MACHINES ON THE THEORY THAT IF THEY WERE DESTROYED AT THE START, OLD JOBS AND OLD WAYS OF LIFE COULD BE PRESERVED.

MEMORY: A DEVICE INTO WHICH INFORMATION CAN BE COPIED AND STORED FOR LATER USE.

MICROWAVE: APPLIES TO COMMUNICATIONS SYSTEMS IN WHICH THE TRANSMITTING AND RECEIVING ANTENNAS ARE IN VIEW OF EACH OTHER.

MODEM: AN ABBREVIATION OF THE WORDS "MODULATOR-DEMODULATOR." IT IS A DEVICE WHICH PERMITS COMPUTERS TO TRANSMIT INFORMATION OVER REGULAR TELEPHONE LINES. DIGITAL ELECTRONIC SIGNALS, GENERATED BY THE COMPUTER, ARE CONVERTED BY THE MODEM INTO HIGH AND LOW TONES. THIS PROCESS IS KNOWN AS "MODULATION." THE TONES ARE A TYPE OF ANALOG SIGNAL. THE MODEM ALSO CONVERTS ANALOG SIGNALS TO DIGITAL SIGNALS.

MONITOR: 1. A VIDEO DISPLAY UNIT WHICH USES A CATHODE RAY TUBE TO GENERATE CHARACTERS. IT LOOKS MUCH LIKE A NORMAL TV SET; HOWEVER, THE MONITOR HAS A MUCH HIGHER DEGREE OF RESOLUTION, WHICH PERMITS A CLEAR FORMATION OF VERY SMALL CHARACTERS ON THE SCREEN. 2. A PROGRAM WHICH OVERSEES THE OPERATION OF OTHER PROGRAMS.

OUTPUT: INFORMATION EMANATING FROM A COMPUTER.

PASCAL: A HIGH LEVEL COMPUTING LANGUAGE DESIGNED TO ENABLE TEACHING OF PROGRAMMING AS A SYSTEMATIC DISCIPLINE AND TO DO SYSTEMS PROGRAMMING.

PRINTER: A PERIPHERAL DEVICE WHICH ACCEPTS OUTPUT DATA FROM THE MICROPROCESSOR AND PRINTS CHARACTERS ON PAPER.

PROGRAM: A SERIES OF INSTRUCTIONS TO A COMPUTER WHICH CAUSE THE COMPUTE R TO SOLVE A PROBLEM OR PERFORM A TASK.

SCROLLING: A TECHNIQUE OF DISPLAYING DATA ON A CRT SCREEN. EACH LINE OF DATA APPEARS FIRST AT THE BOTTOM AND MOVES UPWARD AS NEW LINES ARE DISPLAYED. EVENTUALLY THE LINE DISAPPEARS OFF THE TOP OF THE SCREEN.

SOFTWARE: REFERS TO PROGRAMS AND/OR ROUTINES AND ACCOMPANYING DOCUMENTATION. SOFTWARE IS STORED ON TAPES OR DISCS WHEN NOT BEING USED BY THE COMPUTER. THE COMPUTER READS THE SOFTWARE INTO ITS MEMORY IN ORDER TO USE THE PROGRAMS.

STORAGE CAPACITY: THE QUANTITY OF BYTES A STORAGE DEVICE CAN HOLD. IT IS USUALLY EXPRESSED IN KILOBYTES WHICH IS ABBREVIATED KB. THUS, A DISC IS SAID TO HAVE A STORAGE CAPACITY OF 400 KB (400,000 BYTES). THIS CAN BE UNDERSTOOD AS 400,000 CHARACTERS SUCH AS LETTERS, NUMBERS, SPACES, ETC.

TELECOMMUNICATIONS: EXCHANGE OF INFORMATION BY ELECTRICAL TRANSMISSION OVER GREAT DISTANCES.

TERMINAL: A PERIPHERAL DEVICE WHICH FACILITATES HUMAN COMMUNICATION WITH A COMPUTER. USUALLY IT CONSISTS OF A KEYBOARD WITH ALPHABETIC AND NUMERIC CHARACTERS COUPLED WITH A PRINTING MECHANISM OR A CRT. ONE ENTERS INFORMATION VIA THE KEYBOARD; THE COMPUTER RESPONDS VIA THE PRINTER OR CRT.

TEXT EDITOR: A SYSTEM OF PROGRAMS WHICH FACILITATE EDITING. THE FUNCTIONS AVAILABLE USUALLY CONSIST OF ADDING TEXT, DELETING TEXT, SEARCHING FOR SPECIFIED TEXT, PARAGRAPHING, AND PAGE LAYOUT. SEE: EDITOR.

WINDOW: REFERS TO PARTITIONING A COMPUTER DISPLAY INTO INDEPENDENT SEGMENTS. A CRT SCREEN MAY BE DIVIDED INTO SEGMENTS, ONE OF WHICH MAY CONTAIN EXPLANATORY TEXT, ANOTHER PICTURES OR OTHER GRAPHIC SYMBOLS, AND THE THIRD SEGMENT REPRESENTING QUESTIONS PERTAINING TO THE TEXT AND PICTURES. THE FOURTH SEGMENT COULD PRESENT RESPONSES TO THE STUDENT'S ANSWERS TO THE QUESTIONS. THE CONTENTS OF EACH SEGMENT OR WINDOW COULD BE VARIED INDEPENDENTLY OF ANY OTHER WINDOW.

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